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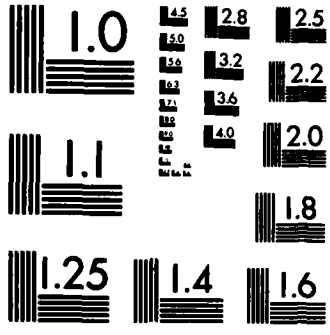

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Atmospheric methane data were collected by NRL personnel in the Arctic and subarctic regions from 1971 to 1979. These data show an average increase of approximately 0.5% per year. It is in agreement with other published results which indicate a 0.5% to 0.6% per year increase. The data do not support the increase of 2% per year obtained by extrapolating methane measurements obtained from 1979 to 1981. No information is available from the NRL data to determine if the increase will continue at its present rate (2%/yr), decreases or become cyclic.

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CONTENTS

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ATMOSPHERIC METHANE CONCENTRATIONS IN THE ARCTIC AND SUBARCTIC REGIONS: 1971-1979

INTRODUCTION

Knowledge about the variations of atmospheric CH_4 concentrations is important in view of its role in the carbon, hydrogen and OH cycles In the stratosphere, CH_4 reacts with Cl to produce HCl, thus terminating the catalytic destruction of ozone by Cl atoms. Oxidation of CH_4 may contribute more water vapor to the stratosphere. It has been estimated that 10 to 35% of the annual production of CO comes from the oxidation of CH_4 in the troposphere. CH_4 and CO are net sinks controlling tropospheric hydroxyl radical densities [1]. Consequently, there is considerable interest in whether the CH_4 concentration in the atmosphere has been increasing in recent years. It has been shown that there are latitudinal variations [2,3] with the Southern Hemisphere having a lesser CH_4 concentration. Seasonal effects can be observed as well and usually can be explained if proper care has been taken in using meteorological data [4,5]. Variations with altitude also have been found [6,7]. Recent evidence indicates that there is an increase of tropospheric CH_4 concentration with time as well as a seasonal variation in both the Northern and Southern Hemispheres [7,8]. This evidence indicates an increase of 2.0 $\pm$ 0.5% per year. Seiler reports a similar increase over Western Europe from 1977 to 1981 [9]. It has been estimated, through some earlier though more indirect evidence, that the increase from 1968 to 1977 amounts to approximately 0.1 ppm over that decade (0.6% per year) [10].

The purpose of this report is to bring together data obtained over the last eight years by NRL personnel in the Arctic and Subarctic areas and to see if there is some increase of CH_4 concentrations with time. The method of analysis was gas chromatography using a flame-ionization detector [11]. Table 1 lists the values obtained at various locations and times. Figure 1 shows approximately where these data were collected. We have made the assumption that there is an insignificant difference between samples collected at 300 m above the sea surface from an aircraft and these collected approximately 7 m above the sea surface from a ship.

DATA ANALYSIS

The data in Table 1 can be divided into three groups which appear to correspond to seasonal ranges of concentrations. The highest values occurred in the winter of 1974. The samples were collected from an aircraft over the Arctic and averaged 1.61 $\pm$ 0.05 ppm. The atmospheric circulation in the Greenland-Spitsbergen region in winter is dominated by the Icelandic low with a corresponding flow of continental (European) air into the Arctic region [5].

The second group consists of summer (July/Aug.) data collected in the Norwegian-Greenland Sea, 1971 (1.38 $\pm$ 0.05 ppm), N. Atlantic, 1976 (1.42 $\pm$ 0.03 ppm) and the Bering Seas, 1977 (1.43 $\pm$ 0.02 ppm). All of these samples were collected from a ship. The prevailing air mass flow in this area is circumpolar with what appears to be little industrial input. Also, the anthropogenic input due to the wintertime consumption of fossil fuels has decreased substantially and is probably reflected in these values.

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Table 1 — CH_4 Values Obtained at Various Locations and Times

Year	Season/Month	Area	Concentration ppmv	No. of Samples	Method of Collection
1971	Summer (Aug)	Norwegian-Greenland Sea	1.38 ± 0.06	90	Ship
1974	Winter (Jan)	Arctic	1.61 ± 0.05	11	Plane
1975	Spring (May)	Arctic	1.48 ± 0.02	20	Plane
1976	Summer (Jul/Aug)	N. Atlantic	1.42 ± 0.03	17	Ship
1977	Summer (Aug)	Bering Sea	1.43 ± 0.02	86	Ship
1979	Spring (Apr)	Norwegian-Greenland Sea	1.48 ± 0.03	133	Ship

The third group occurs in the spring. In 1975, samples collected by aircraft over the Arctic gave a mean value of 1.48 ± 0.02 ppm and more recent samples (1979) collected onboard a ship in the Norwegian-Greenland Sea area gave a mean value of 1.48 ± 0.03 ppm. It is important to consider the meteorology at the time of sample collection, since the samples can be influenced by strong point or regional sources.

DISCUSSION

Recent evidence indicates that the atmospheric CH_4 concentration is increasing at a rate of 1 to 2% per year in the Northern Hemisphere [8,9,12]. However, previous data collected between 1948 and 1975 indicate a much slower rate of increase. The older data show an increase of 0.5 to 0.7% per year [10,13,14]. The NRL data do not show a totally clear cut picture. One of the problems is with seasonal variations. Fraser et al. [12] show a definite seasonal variation for both the Northern and Southern Hemispheres. The Northern Hemisphere has a low point in the July-Aug. time frame with a high value in the Oct.-Nov. time period. The NRL data have the lowest CH_4 concentrations occurring during summer while the highest occur in winter, thus somewhat substantiating the cycle (i.e., NRL data were taken at different locations and were not continuous, while Fraser et al. [12] worked at one location for 2 to 3 years). The second problem with the NRL data is involved with widely spaced geographical sites. This type of global sampling makes it more difficult to establish trends for various areas.

There are, however, two sets of data which were collected in approximately the same area. These are the 1971 and 1979 samples collected in the Norwegian-Greenland Sea from a ship. These values indicate an increase of approximately 0.7% per year. Using all of the NRL data for the time sequence from 1971 to 1979, we obtain an average increase of approximately 0.5% per year.

Based on the NRL data, there appears to be a slight increase of approximately 0.5% per year for the Arctic and Subarctic region for the years 1971 to 1979. The data does not support a 2% per-year increase (extrapolated) for the years 1948 to 1978 claimed by Rasmussen and Khalil (8). The 1-2% per-year increase from 1978 to 1981 appears to be well substantiated and may herald a faster rate of CH_4 increase in the future than has been found in the past. Whether this increase will continue like the CO_2 increase [15] or whether it will decrease or become cyclic is open to speculation.

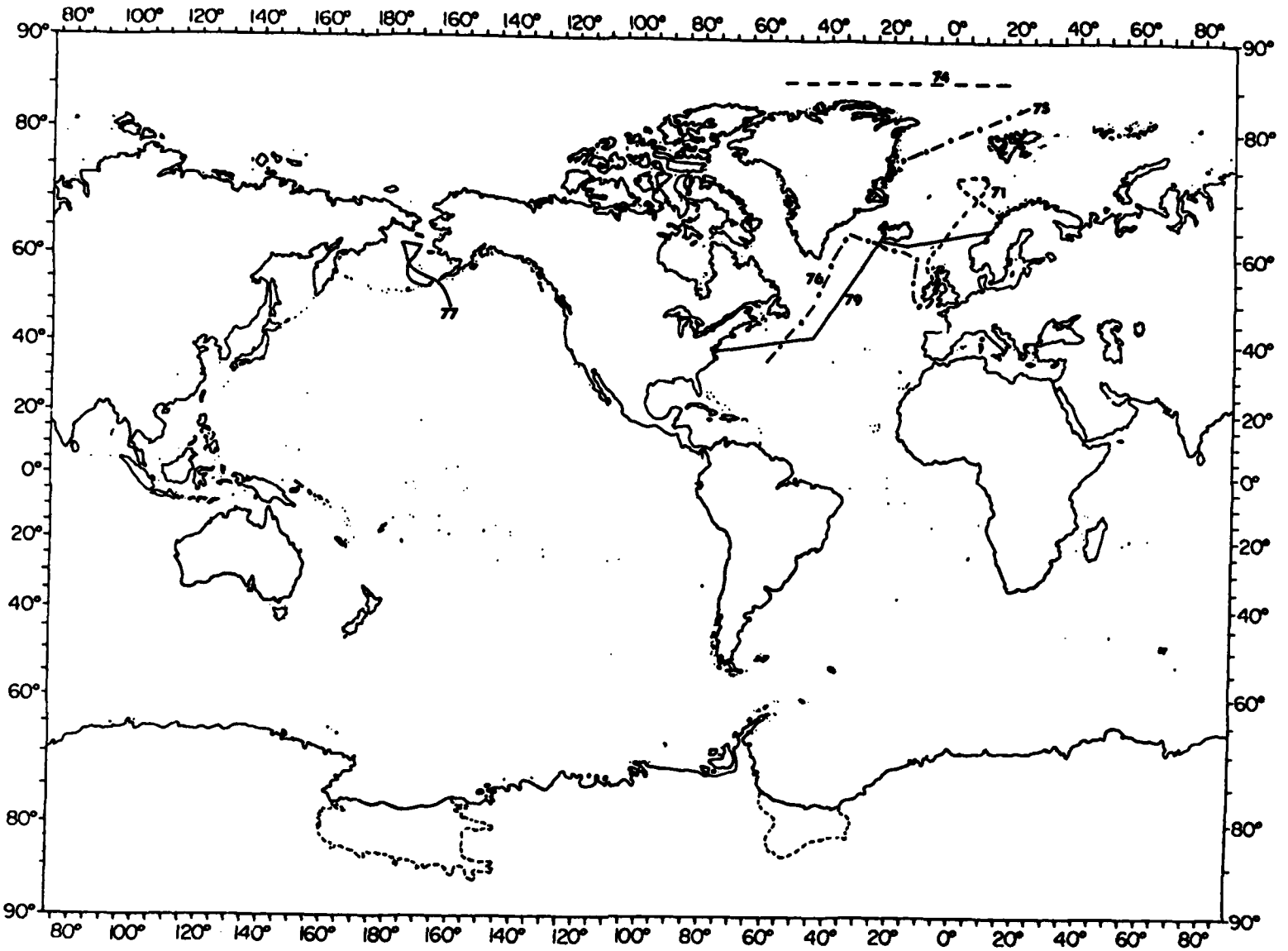

Fig. 1 — Data collection areas. The ship cruise tracks and airplane flight patterns have been smoothed out to simplify the figure. Numbers alongside tracks indicate year data were taken. Numbers 74 and 75 located above 75°N are the plane flight patterns.

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